THIRTEENTH REPORT TO THE GOVERNOR AND GENERAL ASSEMBLY

Regarding the Progress of the:

DELAWARE WATER SUPPLY COORDINATING COUNCIL

Water Supply and Demand Projections for Northern New Castle County through 2030

June 2018

Prepared by the:

Delaware Department of Natural Resources and Environmental Control

Delaware Geological Survey

University of Delaware Water Resources Center

Foreword

I have the pleasure of forwarding to you the latest report of the Delaware Water Supply Coordinating Council (WSCC), regarding *Water Supply and Demand Projections for Northern New Castle County through 2030*. This is the Thirteenth Report issued by the WSCC since its formation by the 140th General Assembly in July of 2000. This report is an update to the water supply and demand projections for northern New Castle County presented to the Governor and General Assembly as published in the Eighth Report in 2006.

The summer of 2016 through winter of 2017 saw much of the Mid-Atlantic region in, or very near, drought conditions, and it is a testament to the planning efforts of the Water Supply Coordinating Council and the associated capital improvements by the water purveyors that Delaware continued to have reliable supplies. Key findings and recommendations in the Thirteenth Report highlight the stable water demands in Northern New Castle County and the established capacity to meet those demands. Additionally, the need for continued diligence in monitoring climatic drought indicators remains as does the challenge of confronting degraded source water quality in areas of northern New Castle County.

I would like to express my sincere thanks to the Water Supply Coordinating Council members for their continued commitment to this precious resource and their understanding of the significance it plays in the vitality of our State.

Shawn M. Garvin, Secretary
Delaware Department of Natural Resources and Environmental Control
Dover, Del.

Thirteenth Report to the Governor and General Assembly
Regarding the Progress of the Delaware Water Supply Coordinating Council

1. Introduction

The purpose of this 13th Report to the Governor and General Assembly regarding the progress of the Delaware Water Supply Coordinating Council (WSCC) is to update projections of water supply and demand in northern New Castle County, Delaware through 2030. This report updates projections through 2020 published in the 8th Report to the Governor and General Assembly in June 2006. This is the thirteenth in a series of WSCC reports to the Governor and General Assembly dating to 2000 (see www.wrc.udel.edu).

2. Delaware Water Supply Coordinating Council

In July 2000, Governor Carper signed HB 549 that formed the Water Supply Coordinating Council and designated the Secretary of the Department of Natural Resources and Environmental Control (DNREC) as Chair, Delaware Geological Survey as technical advisor, and University of Delaware Water Resources Agency as "Temporary Water Coordinator". The WSCC is created and empowered by 26 Del. C. Sections 1305 through 1308 and further empowered by 26 Del. C. Chapter 14. The Delaware Water Supply Coordinating Council Act of 2003 authorized the WSCC to develop and publish water supply plans in Delaware. In July 2014, Governor Markell signed amendments passed by the 147th General Assembly that extended the duties and responsibilities of the WSCC from January 1, 2016 to January 31, 2022. By law, the Council shall have the following members:

a. The Secretary of the Department of Natural Resources and Environmental Control or Secretary's designee
b. The Secretary of the Department of Agriculture or the Secretary's designee
c. The Executive Director of the Public Service Commission or the Executive Director's designee
d. The Director of the Delaware Emergency Management Agency or the Director's designee
e. The Director of the Division of Public Health or the Director's designee
f. The Public Advocate or the Public Advocate's designee
g. The Director of the Delaware Geological Survey or the Director's designee
h. The Director of the Water Resources Agency at the University of Delaware or the Director's designee
i. The Executive Director of the Delaware River Basin Commission or the Executive Director's designee
j. A representative of the office of the Governor
k. A representative of each of the governments of New Castle County, Kent County, and Sussex County
l. A representative of each public and private water utility serving New Castle County
m. A representative of public water supply utilities from the Sussex County Association of Towns
n. A representative of public water supply utilities of Kent County from the League of Local Governments
o. A representative from the Delaware Rural Water Association
p. A representative from the Delaware Chapter of the National Association of Water Companies
q. One representative from Chambers of Commerce in New Castle County, Kent County, and Sussex County
r. A representative of the Delaware State Chamber of Commerce
s. A representative of the New Castle County Chamber of Commerce
t. A representative of the Delaware Nursery and Landscape Association
u. A representative of the Delaware Grounds Management Association
v. A representative of the Delaware State Golf Association
w. A representative of the Delaware Nature Society
x. A representative from the Delaware Farm Bureau
y. A representative from the Center for Inland Bays
z. The State Fire Marshal or the State Fire Marshal's designee
aa. A representative from the Civic League of New Castle County
bb. A representative from the Coalition of Natural Stream Valleys
cc. The State Climatologist or State Climatologist's designee.

The Secretary of the DNREC or the Secretary's designee shall serve as Chair of the Council.

3. Water Conditions

During the summer of 2016, Delaware experienced the warmest August on record in 122 years. During September 2016, the flow on Brandywine Creek at Wilmington declined to 80 cubic feet per second (cfs) and flow on White Clay Creek near Newark declined to 16 cfs, among the lowest flows recorded since the drought of 2002 (Figure 1). Chloride levels at Christina River at Newport reached 700 parts per million (ppm), well above 250 ppm used as an indicator in the Northern Delaware Drought Advisory Guidelines (Figure 2).

On September 19, 2016 the WSCC held a meeting in Dover to review Northern New Castle County Drought Advisory Guidelines prepared by the Delaware Geological Survey (DGS). The WSCC deliberated and decided not to recommend drought watch as the Delaware Environmental Observing System (DEOS) recorded 1.3 inches of rain at the UD farm in Newark. Delaware last declared a drought watch in October 2007 and in 2012 DNREC released a statement affirming conditions were dry, however, a drought watch was not declared then. Most WSCC members agreed at the September 19, 2016 meeting that reservoir capacity, system interconnections, and periodic rainfall events provided safeguards for northern Delaware water supply resiliency.

On September 29, 2016 the WSCC met at its quarterly meeting to review water conditions. The DGS summarized hydrologic conditions tied to the Northern Delaware Drought Advisory Guidelines (Figure 2). The State Climatologist presented 24-hour rainfall recorded by DEOS stations in Delaware (Figure 3). The WSCC deliberated and given the recent rain and impending forecast of more rain from Hurricane Matthew, decided not to recommend drought watch in northern Delaware.

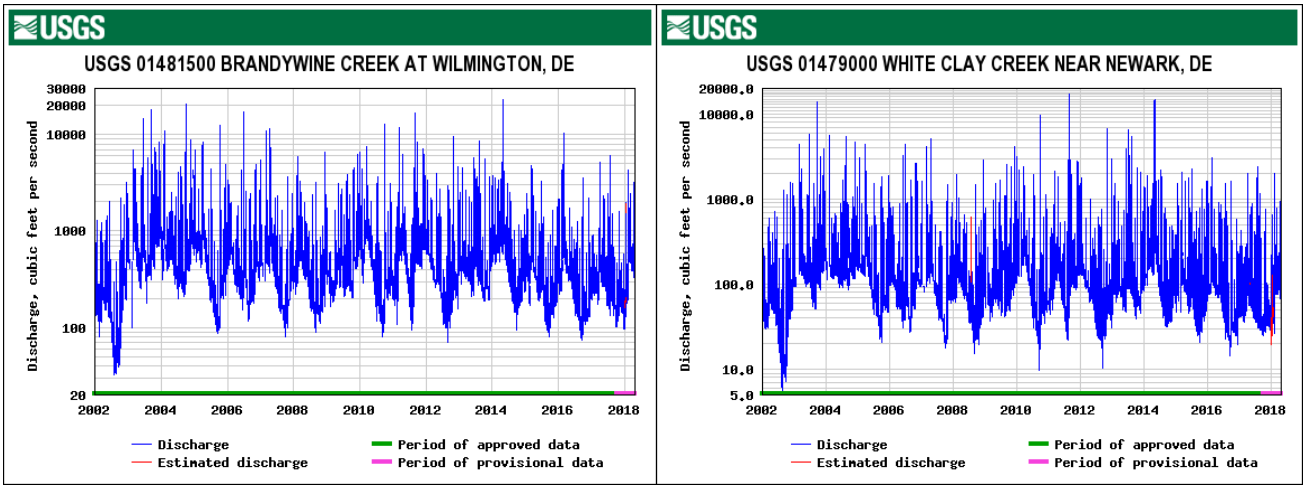

Figure 1. Streamflow along the Brandywine Creek and White Clay Creek since 2002.

On January 26, 2017, the WSCC met at its quarterly meeting to review water conditions. None of the water providers voiced concern about adequacy of supply. The 12-month precipitation, while still in deficit, decreased from -4.19 to -2.76 inches. However, the 6-month precipitation deficit actually increased from -3.32 to -4.36 inches. Streamflows (30-day moving average) increased to the normal range. The groundwater station remained in drought warning. Other positive indicators included receding of the Delaware River salt line to normal, cessation of Marsh Creek Reservoir releases into the Brandywine River in Pennsylvania, and Hoopes and Newark reservoirs returning to near normal capacity. The DRBC lifted a drought watch for the Delaware River Basin on January 18, 2017.

On April 19, 2018, the WSCC met in Dover to review water conditions. The DGS and State Climatologist reported that since 2017, higher than normal precipitation boosted water conditions, easing concerns about drought. At present, water conditions in northern Delaware are in the normal range for this time of year (Figure 4) and the providers are confident of supply.

Northern Delaware Drought Advisory Guidelines

Reported by the Drought Advisory Guidelines Subcommittee (DAGS), which is composed of the Delaware Department of Natural Resources and Environmental Control, Delaware Geological Survey, and University of Delaware Water Resources Agency with input from the water purveyors and representatives from the landscaping industry. These drought operating guidelines are designed to provide guidance to the Delaware Water Supply Coordinating Council (WSCC) and the Governor's Drought Advisory Committee (GDAC). Responsibility for providing technical guidance for a move up to or down from Drought Watch is with the WSCC. Responsibility for providing technical guidance for a move up to or down from Drought Warning or Emergency is with the GDAC. Final declaration of drought advisories rests with the Governor.

Indicators	Drought Watch Voluntary Conservation	Drought Warning Voluntary Conservation	Drought Emergency Mandatory Restrictions	Status Sept. 28, 2016
Precipitation Wilmington Airport 12-month	-6.00" to -8.99"	-9.00" to -11.99"	>-12.00"	-2.87" (deficit increased by 0.48")
Precipitation Wilmington Airport 6-month	-3.00" to -4.50"	-4.50" to- 6.00"	>-6.00"	-1.90" (deficit increased by 0.49")
Brandywine Creek (30-day moving avg)	85 mgd	70 mgd	48 mgd	75.5 mgd (flow increased by 2.9 mgd)
White Clay Creek - Stanton (30-day moving avg)	42 mgd	37 mgd	31 mgd	33.1 mgd (flow increased by 1.0 mgd)
White Clay Creek - Newark (30-day moving avg)	19 mgd	16 mgd	13 mgd	14.3 mgd (no change)
Well Db24-18	14 - 14.99 (fbls)	15 - 15.99 (fbls)	16 (fbls)	13.81 (fbls) (gw level declined by 0.44 ft)
Water Conditions Index	4.0-5.0	3.0-3.99	<3.00	4.35 (Index increased by .22)
Chlorides	WCC ≤ 37 mgd for 5 consecutive days at SUEZ Stanton Intake	Cl > 250 ppm for 3 days at Christina River at Newport	Cl > 250 ppm for 3 days at UWD Stanton Intake	Monitoring 512 ppm (Cl decreased by 163 ppm)
Hoopes Reservoir (City of Wilmington)	-10 ft (68% capacity)	-12 ft (64% capacity)	-15 ft (57% capacity)	-3.7 ft (9/19/2016)
Newark Reservoir	- 10 ft (70% capacity)	-17 ft (52% capacity)	-27 ft (28% capacity)	-11.0 ft (9/16/2016)
Monitored				
Aquifer Storage and Recovery	Monitor Status	Monitor Status	Monitor Status	SUEZ: .102mg (9/6/2016) AWC: 49 mg (9/19/2016)
Octoraro Reservoir (Chester Water Authority)	Monitor Status	Monitor Status	Monitor Status	
Marsh Creek Reservoir	Monitor Status	Monitor Status	Monitor Status	PA DCNR releasing ~7.8 mgd into Brandywine Creek
Chlorides on the Delaware River 9/22/2016	Monitor Status	Monitor Status	Monitor Status	Normal RM: 76 Current RM: 82 (Commodore Barry Bridge)
DRBC Lower Basin Drought Criteria	Monitor Status	Monitor Status	Monitor Status	
NYC DRB Reservoirs (DRBC 9/23/2016)	Monitor Status	Monitor Status	Monitor Status	Storage 180.3 bg or 63 bg above drought watch

Figure 2. Northern Delaware Drought Advisory Guidelines as of September 28, 2016 (DGS)

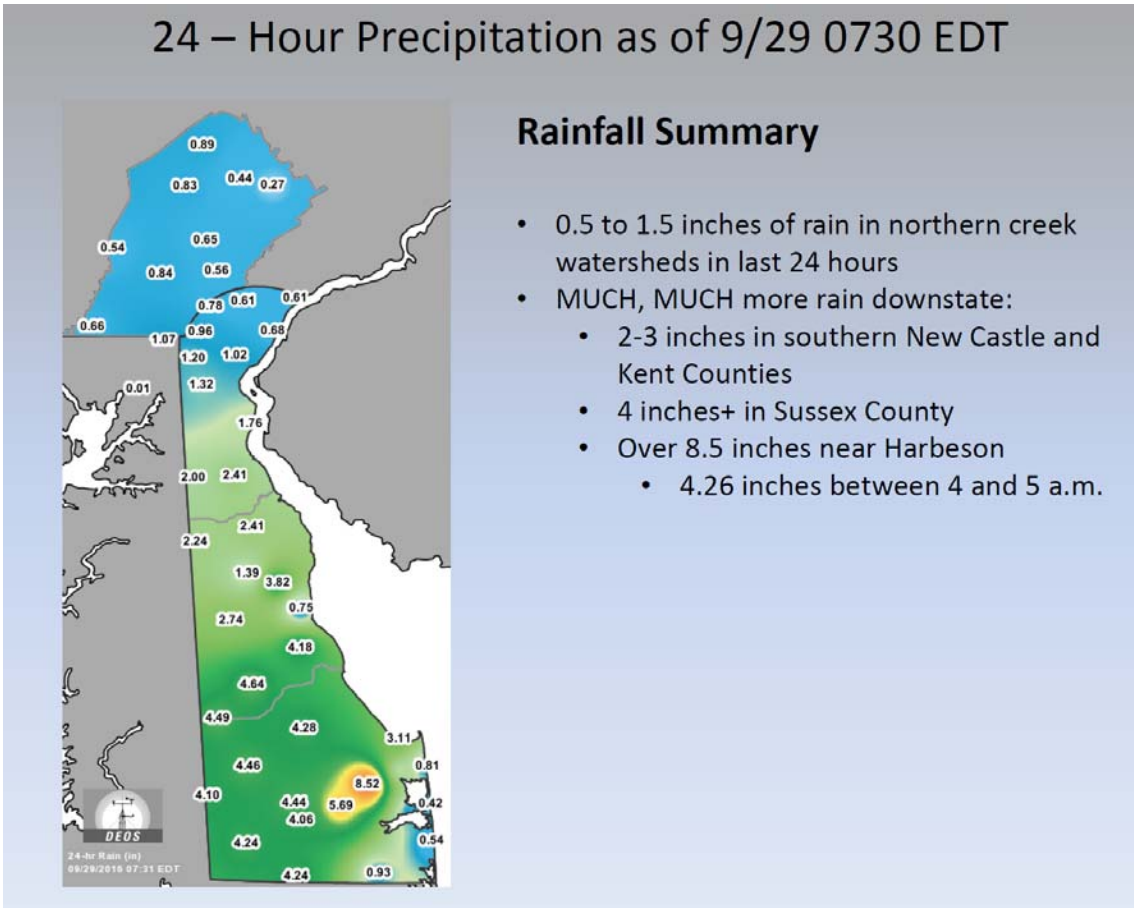

Figure 3. 24-hour precipitation as of September 29, 2016 (DEOS)

Northern Delaware Drought Advisory Guidelines

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Indicators	Drought Watch Voluntary Conservation	Drought Warning Voluntary Conservation	Drought Emergency Mandatory Restrictions	Status Mar 31, 2018
Precipitation Wilmington Arprt/Porter Rsvr 12-month	-6.00" to -8.99"	-9.00" to -11.99"	>-12.00"	+0.79
Precipitation Wilmington Arprt/Porter Rsvr 6-month	-3.00" to -4.50"	-4.50" to- 6.00"	>-6.00"	-0.49"
Brandywine Creek (30-day moving avg)	85 mgd	70 mgd	48 mgd	400.5 mgd
White Clay Creek - Stanton (30-day moving avg)	42 mgd	37 mgd	31 mgd	158.3 mgd
White Clay Creek - Newark (30-day moving avg)	19 mgd	16 mgd	13 mgd	67.1 mgd
Well Db24-18	14 - 14.99 (fbls)	15 - 15.99 (fbls)	16 (fbls)	13.81 (fbls)
Water Conditions Index	5.0-4.0	3.99-3.00	<3.00	9.08
Chlorides	WCC ≤ 37 mgd for 5 consecutive days at SUEZ Stanton Intake	Cl > 250 ppm for 3 days at Christina River at Newport	Cl > 250 ppm for 3 days at UWD Stanton Intake	Average 78.12 ppm (3/31/2018)
Hoopes Reservoir (City of Wilmington)	-10 ft (68% capacity)	-12 ft (64% capacity)	-15 ft (57% capacity)	-1.2ft (3/7/2018)
Newark Reservoir	- 10 ft (70% capacity)	-17 ft (52% capacity)	-27 ft (28% capacity)	-6.0 ft (3/5/2018)
Monitored				
Aquifer Storage and Recovery	Monitor Status	Monitor Status	Monitor Status	SUEZ: 29 mg (1/25/2018) AWC: 15 mg (3/6/2018)
Octoraro Reservoir (Chester Water Authority)	Monitor Status	Monitor Status	Monitor Status	
Marsh Creek Reservoir	Monitor Status	Monitor Status	Monitor Status	
Chlorides on the Delaware River 3/29/2018	Monitor Status	Monitor Status	Monitor Status	Normal RM: 70 Current RM: 74
DRBC Lower Basin Drought Criteria	Monitor Status	Monitor Status	Monitor Status	
NYC DRB Reservoirs (DRBC 3/30/2018)	Monitor Status	Monitor Status	Monitor Status	Storage 249.8 bg or 77 bg **above** drought watch

fbls = feet below land surface
mg = million gallons
mgd = million gallons per day
RM = River Mile
bg = billion gallons

Figure 4. Northern Delaware Drought Advisory Guidelines as of March 31, 2018 (DGS)

4. Water Supply

Through the efforts of the WSCC, water purveyors in northern New Castle County have developed over 2 billion gallons (bg) in reserve water supplies since the drought of 1999 to provide a healthy surplus of supply to meet peak demands during the next drought and providing a reserve to meet new economic development in Delaware (Table 1). These reserve water supplies (the "A" list) are designed to meet conditions experienced during a period of 75 days of climatological, streamflow and groundwater conditions similar to those that prevailed in northern New Castle County during the drought emergency of 2002 and based on peak water demands forecast for the population in 2030.

Table 1. Water supply developed since the drought of 1999 in northern New Castle County, Delaware.

Sponsor	Project	Capacity (mg)
Artesian Water Company	New Wells North of C&D Canal	405
Artesian Water Company	Aquifer Storage and Recovery	130
City of Newark	Newark Reservoir	317
City of Newark	South Wellfield Iron Treatment Plant	75
SUEZ Delaware	Modify Tidal Capture Structure Plan	400
SUEZ Delaware	Aquifer Storage and Recovery	75
City of Wilmington	Hoopes Reservoir Deep Storage Plan	500
City of Wilmington	Raise Hoopes Reservoir Water Level by 2 ft	150
		2,052

5. Water Demand

Water demand as recorded during 2017 by the five water purveyors in northern New Castle County was below normal and ranged between 46 and 64 mgd (Figure 5).

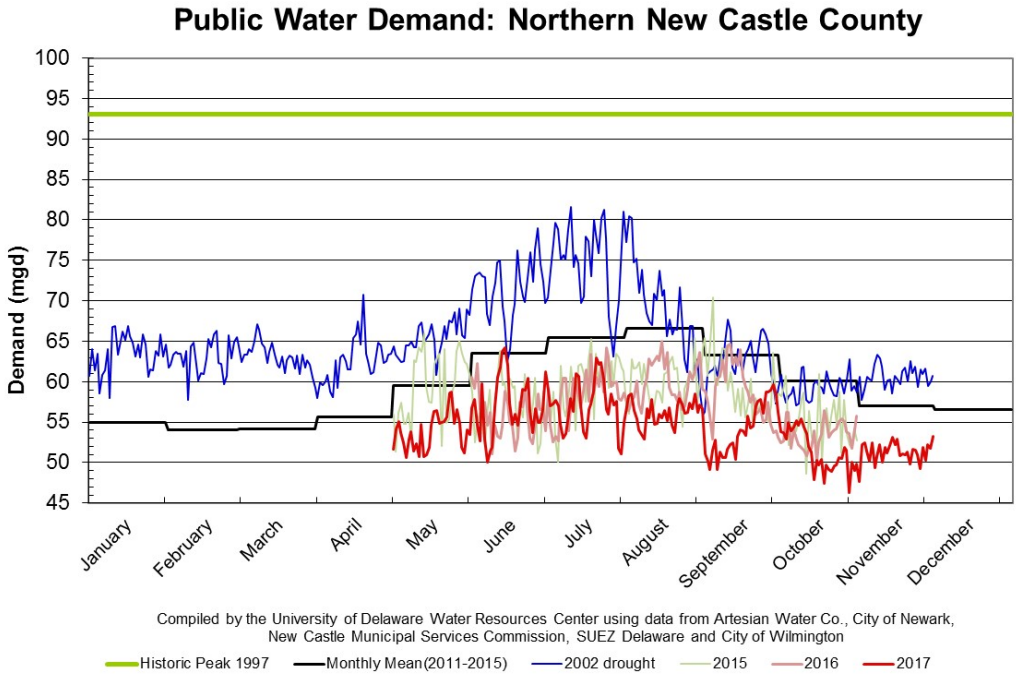

Figure 5. Water demand recorded in northern New Castle County, Delaware

With completion of water supply projects (over 2 billion gallons) since the drought of 1999 (see Table 1), the WSCC has updated water supply and demand projections for northern New Castle County through 2030. The 2015 base demands are selected as the maximum peak monthly water demand recorded for each purveyor for the 5-year period from 2011 through 2015 (Table 2). Maximum water demands during this 5-year period were recorded in 2011 and are therefore utilized as the 2015 base demand for water demand projections to 2020 and 2030.

Table 2. Maximum monthly water demands recorded in northern New Castle County, Delaware

Purveyor	2011 (mgd)	2012 (mgd)	2013 (mgd)	2014 (mgd)	2015 (mgd)	2015 base[1] (mgd)
City of Wilmington	21.3	18.8	17.3	17.2	17.2	21.3
Artesian Water Company	19.8	20.0	18.0	19.8	19.2	19.8
SUEZ Delaware	20.4	20.5	17.8	18.6	20.4	20.4
City of Newark	3.9	4.1	3.5	3.8	3.5	3.9
New Castle MSC	0.6	0.5	0.5	0.5	0.5	0.6
Total (mgd)	**66.0**	**63.9**	**57.1**	**59.9**	**60.8**	**66.0**

1. 2015 base demands are maximum monthly demands recorded in 2011

The Delaware Population Consortium (2016) projected that the population in northern Delaware (north of the C&D Canal) will increase by 3.2% from 489,499 in 2015 to 505,288 by 2030 or by 1.6% from 2015 through 2020 and another 1.6% from 2020 through 2030. (Table 3). Northern New Castle County is nearing full build-out, therefore, population increases are projected to be low.

Table 3. Projected population in northern New Castle County through 2030
(Delaware Population Consortium, Nov 2016)

Year	Population	% Increase
2015	489,499	---
2020	497,331	1.6%
2030	505,288	1.6%

At a rate proportionate to the Delaware Population Consortium projections, a Subcommittee of the WSCC agreed to project 2015 base demands out to 2020 and 2030 (Table 4 and Figure 6). Water demands are projected to grow from 66.0 million gallons per day (mgd) in 2015 to 67.0 mgd in 2020 and 68.1 mgd in 2030.

Table 4. Maximum monthly water demands in northern New Castle County projected to 2030

Purveyor	2015 base (mgd)	% incr.	2020 (mgd)	% incr.	2030 (mgd)
City of Wilmington	21.3	1.6%	21.6	1.6%	22.0
Artesian Water Company	19.8	1.6%	20.1	1.6%	20.4
SUEZ Delaware	20.4	1.6%	20.7	1.6%	21.1
City of Newark	3.9	1.6%	4.0	1.6%	4.0
New Castle MSC	0.6	1.6%	0.6	1.6%	0.6
Total	**66.0**	**1.6%**	**67.0**	**1.6%**	**68.1**

A logarithmic regression from 2001-2016 shows that demand could decline to about 58 mgd by 2030 (Figure 7), thus projected 2030 demand ranges between 58 mgd and 68.1 mgd (a 15% variance). The high end of the projected range of demand (68.1 mgd) in 2030 is used for planning purposes in this report. Per capita water demand in northern New Castle County has declined from a high of 165 gpcd in 2001 to 125 gpcd by 2015 and is projected to decline and level off to near 120 gpcd by 2030 depending on the trend (Figure 8). The decline in per capita water demand is thought to occur from a variety of factors including growing water conservation ethic

by consumers, rising water rates, rehabilitation of leaking water mains, and aging of neighborhoods that require less lawn watering.

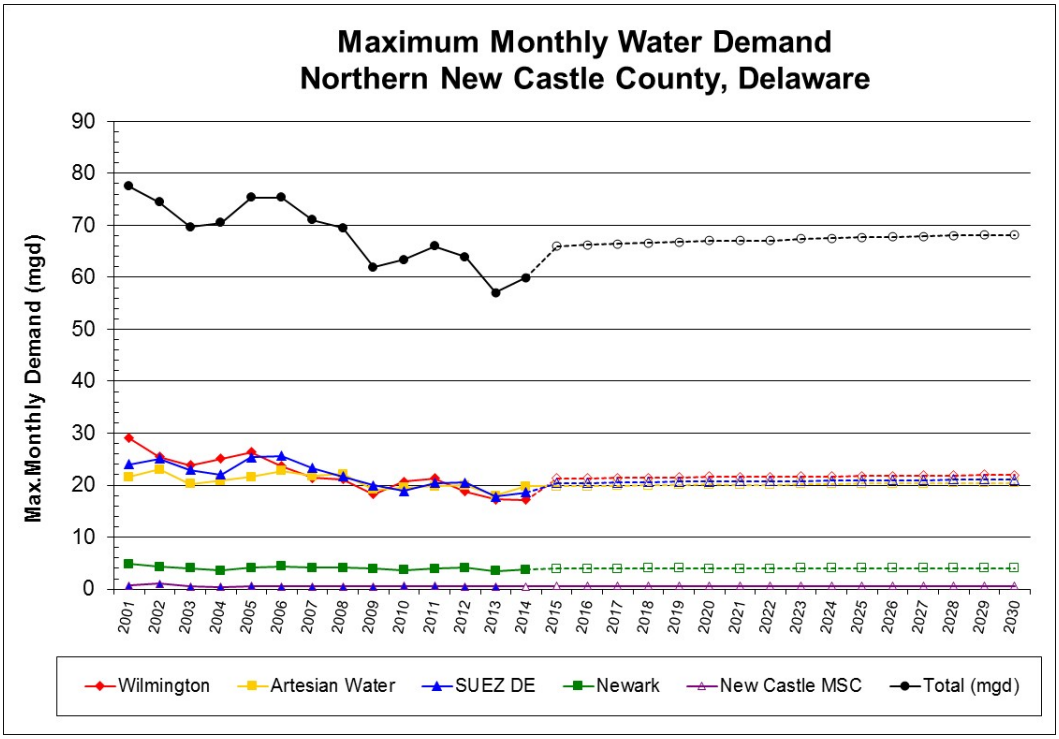

Figure 6. Maximum monthly water demands in northern New Castle County through 2030

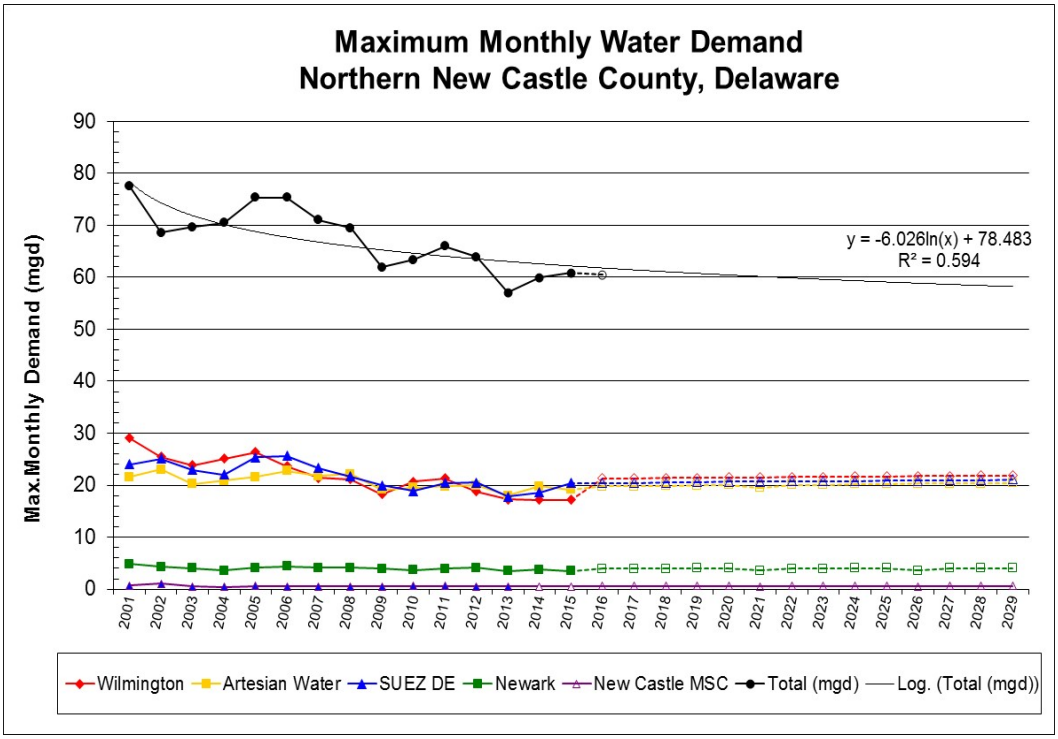

Figure 7. Projected max. monthly water demands in northern New Castle County through 2030

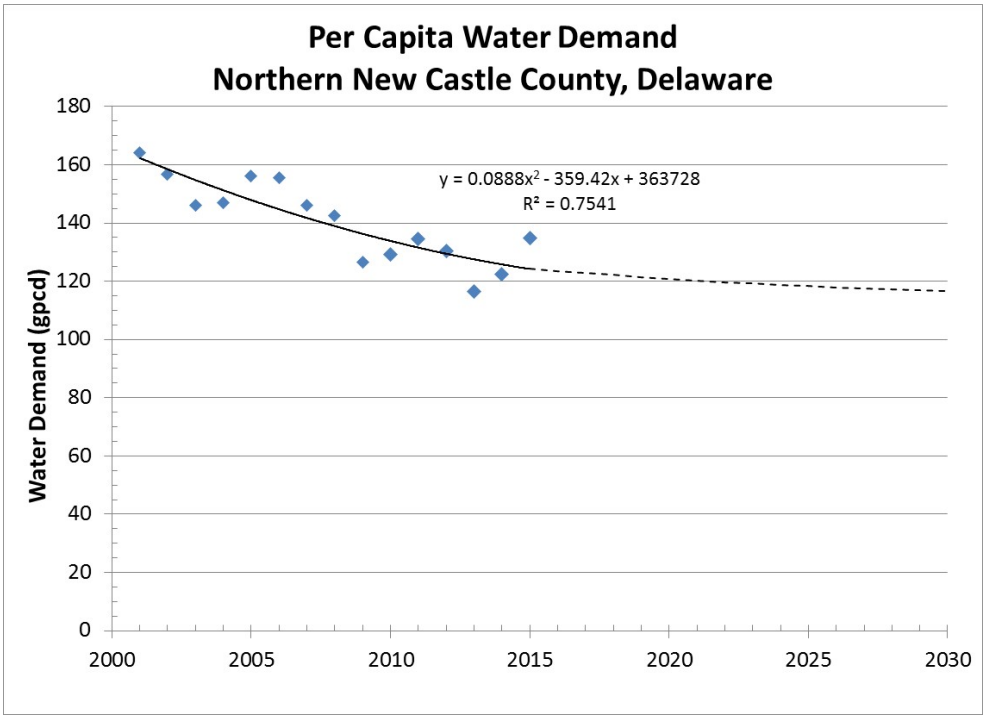

Figure 8. Per capita water demand in northern New Castle County (Solid trendline based on water demands and population recorded from 2001-2015 and dashed trendline projected through 2030).

6. Water Supply and Demand Projections

Water supply and water demands in northern New Castle County are estimated assuming low stream flows likely to occur after 75 days similar to those that occurred in northern New Castle County during the drought emergency of 2002 and based on peak water demands forecast for the population through 2030. In the December 2002 Fifth Report to the Governor and General Assembly, the WSCC decided to plan future water supplies for a 75-day dry period as recorded during the severe drought of 2002. The projections incorporate regulatory standards imposed by the DRBC and DNREC where White Clay Creek at Stanton (SUEZ Delaware) is under a chloride (250 ppm) and 1 foot depth of flow minimum bypass standard and White Clay Creek at Newark has a 7Q10 minimum passby flow standard of 14 mgd. The 7Q10 is the low flow likely to occur for 7 days in a row once every 10 years. The City of Newark has 6.9 mgd production capacity after the loss of two production wells due to contamination. The City currently has two projects budgeted that are anticipated to bring an additional 1.0 mgd online by the end of 2020. If realized, these projects will restore capacity to a level equal to or above the 7.8 mgd shown in Table 6. In 2015, New Castle Municipal Services Commission (MSC) developed a new well (Cross Roads) that raises available supply to 2.3 mgd with a DRBC allocation of 1.6 mgd. By 2030, water supply is projected to exceed demand in northern New Castle County by a surplus of 35.4 mgd or 2,655 mg during a 75-day drought period (Tables 5 and 6).

Table 5. Water supply and demand projections for northern New Castle County through 2030

Year	Supply (mgd)	Demand (mgd)	Surplus	
			(mgd)	(mg)[1]
2015	102.6	66.0	36.6	2,745
2020	103.5	67.0	36.5	2,738
2030	103.5	68.1	35.4	2,655

1. Volume calculated assuming a 75-day drought period.

Table 6. Water supply and demands (mgd) in Northern New Castle County projected through 2030

Purveyor	2015			2020			2030		
	Supply	Max Monthly Demand	Surplus/ Deficit +/-	Supply	Max Monthly Demand	Surplus/ Deficit +/-	Supply	Max Monthly Demand	Surplus/ Deficit +/-
Wilmington	**38.3**	**21.3**	**17.0**	**38.3**	**21.6**	**16.7**	**38.3**	**22.0**	**16.3**
Brandywine Creek	15.0			15.0			15.0		
Hoopes Reservoir	21.3			21.3			21.3		
Raise Hoopes Res.	2.0								
Artesian Water	**29.0**	**19.8**	**9.2**	**29.0**	**20.1**	**8.9**	**29.0**	**20.4**	**8.6**
Groundwater	24.3			24.3			24.3		
CWA Interconn.	3.0			3.0			3.0		
ASR	1.7			1.7			1.7		
SUEZ Delaware	**26.8**	**20.4**	**6.4**	**26.8**	**20.7**	**6.1**	**26.8**	**21.1**	**5.7**
Stanton WTP	19.3			19.3			19.3		
Hoopes Contract	2.7			2.7			2.7		
Christiana WTP	3.0			3.0			3.0		
ASR	1.0			1.0			1.0		
CWA Interconn.	0.8			0.8			0.8		
Newark	**6.9**	**3.9**	**3.0**	**7.8**	**4.0**	**3.8**	**7.8**	**4.0**	**3.8**
White Clay WTP	0.0			0.0			0.0		
Newark Reservoir	4.0			4.0			4.0		
Groundwater	2.9			3.8			3.8		
New Castle MSC	**1.6**	**0.6**	**1.0**	**1.6**	**0.6**	**1.0**	**1.6**	**0.6**	**1.0**
Subtotal	**102.6**	**66.0**	**36.6**	**103.5**	**67.0**	**36.5**	**103.5**	**68.1**	**35.4**

Assumptions of Table 6:
Water supply available during 2002 drought emergency conditions (75 days) with then existing regulatory condition:

- No minimum instream flow standards in effect along the Brandywine Creek at Wilmington.
- Minimum flow standard based on chloride level (250 ppm) and 1 ft minimum tidal flow depth along White Clay Creek at Stanton, 7Q10 passby in effect on White Clay Creek at Newark (14 mgd). The 7Q10 is the low flow likely to occur for 7 days in a row once every 10 years.
- Groundwater supplies are determined as permitted by DRBC and DNREC allocation permits.
- Low streamflows observed during 2002 drought emergency: Brandywine Creek = 21 mgd (8/21/02). White Clay Creek at Stanton (w/o Hoopes Reservoir Releases) = 6.8 mgd (8/15/02).

Other assumptions:

- Maximum monthly demands recorded by water suppliers for 2015 base year, projected to 2020 and 2030 as per Delaware Population Consortium projections with increase 3.2% in northern New Castle County from 2015 to 2030.
- Maximum monthly demands for base year 2015 as recorded during 5-year period (2011-2015).
- The City of Newark has 6.9 mgd production capacity after the loss of two production wells due to contamination. The City currently has two projects budgeted that are anticipated to bring an additional 1.0 mgd online by the end of 2020. If realized, these projects will restore capacity to a level equal to or above the 7.8 mgd shown in Table 6.
- Useable capacity Hoopes Reservoir = 1950 mg over 75 days (26.0 mgd).
- Useable capacity Newark Reservoir = 300 mg over 75 days (4 mgd).
- SUEZ DE Tidal Capture Structure (TCS) provides 14 mgd plus 5.3 mgd from incoming tide 18 hours per day with 1 ft min. depth in creek. Hoopes Reservoir release reduces chlorides below 250 ppm at TCS during low flow (< 17 mgd). Contract with Wilmington provides up to 200 mg from Hoopes Reservoir to SUEZ (2.7 mgd over 75-day drought.
- Transfers from Chester Water Authority (CWA) accounted for as per Water Supply Self Sufficiency Act of 2003.

7. Progress and Activities

Artesian Water Company

Artesian Water Company invested $90 million over the past 5 years in its Delaware water systems. Of that, $22.6 million was invested in its New Castle County water systems to ensure customers can continue to receive uninterrupted delivery of water, including without the need to impose usage restrictions in a recurrence of a drought of record. Specifically, in New Castle County in the past five years, Artesian invested:

- $4.1 million to replace and rehabilitate wells to keep these sources of supply in service.
- $14.1 million to install new treatment systems to ensure all Federal and state drinking water standards are met, to rehabilitate aging treatment and pumping facilities and to install a new booster station for improved system hydraulics and improved flexibility in system delivery.
- $4.4 million to install water main completing the integration of its regional New Castle County water system that reaches from the Pennsylvania state line to Middletown, Odessa, Townsend in southern New Castle County so no source of supply in the New Castle County system is isolated.

City of Newark

The City of Newark has embarked on the following improvements to the municipal water system:

- Installed an aeration facility to reduce algal blooms at the Newark Reservoir in 2016.
- Preparing plans to replace two wells in the South Wellfield taken offline due to contamination from EPA Superfund site.
- Considering referendum to fund modernization of the South Wellfield Water Treatment Plant to provide organic chemical treatment.
- Developing plans to replace chlorine gas disinfection at White Clay Creek water treatment plant with liquid sodium hypochlorite.

City of Wilmington

The City of Wilmington has implemented the following projects in the City water system:

- Completed repair and relining of raceway along Brandywine Creek that feeds the Market Street Filter Plant.
- Repaired gates at Hoopes Reservoir to allow for unimpeded releases.
- Plans to remove West Street Dam No. 1 along Brandywine Creek that encases deteriorating water lines in concrete.

New Castle Municipal Services Commission (MSC)

The New Castle MSC has implemented the following improvements:

- Recognizing the average age of 3 existing water wells being 48 years, MSC drilled and developed an additional 500 gallon per minute (gpm) source water well. Construction of the new Cross Roads well and pump house was completed and integrated into the treatment facility in 2016. MSC will work with DNREC to amend the allocation permit to include the new well with the existing 3 wells while maintaining the current 1.6 mgd allocation.
- Since 2012 MSC has installed 2,700 linear feet of 12-inch main, 2,600 linear feet of 8-inch main, and 590 linear feet of 6-inch main to replace undersized and aging infrastructure eliminating dead end mains, improving water quality, and flow.
- Cleaning and lining projects: Since 2012 MSC has cleaned and lined 580 linear feet of 12-inch main, 1,225 linear feet of 8-inch main, and 1,880 linear feet of 6-inch main improving water quality and flow.
- During August 2014 MSC tested for PFAS Compounds in the raw water and found the wells exceeded the EPA Provisional Health Advisory level for PFOS and PFOA. MSC shut down the treatment facility and began purchasing water through the AWC Interconnection for 4 months while the temporary treatment

system was engineered and installed. The temporary carbon filtration system allowed MSC to utilize the source water and treatment facility while a permanent carbon system was engineered and installed. In November 2015, the permanent granular activated carbon filtration system capable of treating 1.6 MGD of water was put in service.

- Artesian Water Interconnection (AWC): In the fall of 2016, MSC evaluated and rebuilt the 40 HP pump and motor assembly used to supply AWC water through the School Lane treatment facility interconnection. The interconnection was utilized in the spring of 2017 to supply AWC with finished water for 45 days while they performed routine maintenance on their system.

SUEZ Delaware

Over the past five years, SUEZ DE has employed multiple measures to ensure sufficient source water supply to serve a population of 100,000 in northern New Castle County, Delaware:

- Significant among these is restoring the 75-million-gallon Aquifer Storage and Recovery system to full operational status. This "underground reservoir" enables injection and storage of finished water in months when surface source waters are plentiful, and withdrawals of up to one million gallons a day to meet demand in dry weather months.
- SUEZ continues its long standing contract with the City of Wilmington guaranteeing releases from Hoopes reservoir of up to 200 million gallons of raw water annually into the Red Clay Creek to help meet SUEZ customer demand in drought situations.
- In addition, SUEZ maintains numerous interconnections with the City of Wilmington that can provide an added 7.5 million gallons of finished water a day. SUEZ recently automated one of the largest of these interconnections to enable swift deployment in emergency situations.
- SUEZ also is able to utilize its Tidal Capture Structure (TCS) to optimize source water supply in the White Clay Creek.

Appendix

Figure A1. Newark Reservoir filling with geomembrane, concrete, and rock liner (December 2005). The geomembrane provides a waterproof lining in the lower portion of the reservoir and the concrete liner provides wind and erosion control in the upper portion of the reservoir.

Figure A2. Newark Reservoir aeration facility installed during fall of 2016